



Preparing for the Unexpected Future of Autonomous Mobility

The automotive industry is experiencing exponential change, which means the race is on to deliver within a competitive environment that doesn't yet exist.

In this ever-changing market landscape, survival will depend on looking beyond the perceived horizon to the unexpected future.

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Industry Players Must Look to the Unexpected Future

► ABSTRACT

We are at the cusp of a new phase in the history of the automobile. Self-driving vehicles are about to move out of R&D and begin reaching the public. Commercialization will unleash exponential growth in the use of autonomous technology and trigger the most consequential period of change for the industry since the invention of the assembly line. The concepts that emerge from this disruption and succeed commercially are certain to surprise us – but industry players can't afford to be surprised. They need tools to challenge their current assumptions and design today for the unexpected future of tomorrow.

The Road to Automation

► AVS BECOME TECHNOLOGICALLY VIABLE

The creation of the first DARPA Grand Challenge in 2004 was not just the start of a single 150-mile desert race that put current self-driving technology to the test. What began that day was a race towards the successful development of autonomous vehicles (AV), which has only accelerated in recent years. In its first year, not a single entrant finished the race designed to test AVs and promote innovation in the field. A year later, however, five AVs made it to the finish line.¹ Since then, the pace of maturation from scientific exploration to potential commercialization has been staggering. We've seen the reality of AVs go from speculative fiction to an area of actual investment, with developments in machine learning (ML) and artificial intelligence (AI) allowing for autonomous technology to enter a phase of self-propelling urgency.

In the United States, we are witnessing an explosion of autonomous pilot programs. More than 20 states have passed laws allowing (and often attempting to attract) autonomous vehicle testing. Nineteen states and 60 cities are actively hosting pilot programs where self-driving cars encounter real-world conditions and accumulate the miles needed to prepare deep learning systems for commercial deployment. California has even passed legislation allowing self-driving cars to carry passengers without backup drivers.²

As the largest mobility market in the world,³ China is on track to catch up with—and potentially surpass—American technology firms in the capability of their AV programs. The combination of a regulatory environment capable of acting quickly to create favorable testing conditions, capital from technology behemoths and cultural acceptance of new technology combine to create a perfect environment to incubate self-driving technology. Already, more than 300 regions or cities have active “smart city” projects and of those, 93 percent are using artificial intelligence to optimize autonomous transportation.⁴

Elsewhere globally, South Africa will see its first autonomous vehicle pilot program in October of 2018.⁵ And in India, Tata Elxsi, part of the Tata motor group, announced plans to open a testing program outside Bangalore.⁶ Dr. Roshy John, Ph.D in robotics from the National Institute of Technology Tiruchirappalli, managed to spur Tata into action with his \$3,500 autonomous car. He now speculates that even in India's challenging driving environment, the highest level (SAE 5⁷) autonomous cars will be on the road in 10 years.⁸

▶ ENTERING THE NEXT PHASE TO COMMERCIALIZATION

As AVs become viable technology, auto industry giants and tech companies are pushing AVs to be commercially viable as well. For example, Ford's autonomous pilot programs are no longer just an opportunity to test and improve the technology stack powered by Argo.AI. The same pilots now include experiments with Dominos, PostMates and Lyft to simultaneously explore viable business models.⁹

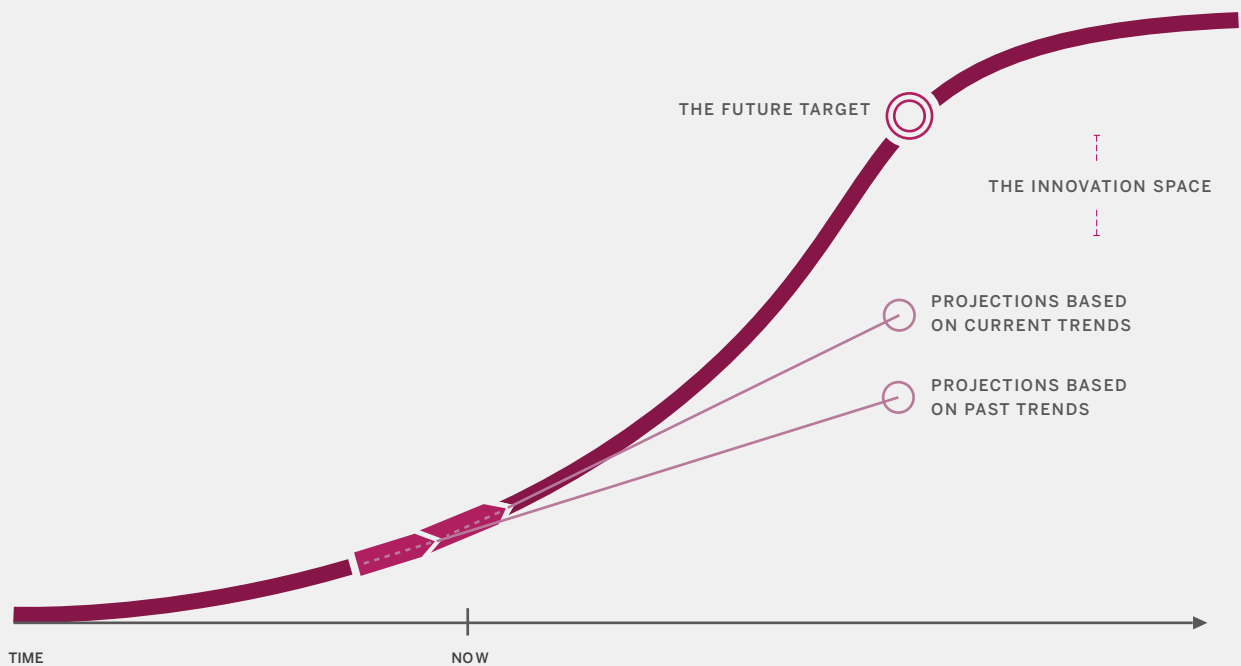
Arizona may be the first state in the US to see commercial autonomous vehicles deployed. Waymo, the self-driving spinoff from Google, received a license to operate as a commercial transportation network company (TNC) from state regulators in late January, 2018.¹⁰ When the program launches, customers will be able to hail, and more critically, pay for rides in self-driving Chrysler Pacifica minivans.¹¹

Lyft's president, John Zimmer, even predicts that a "majority" of rides in the Lyft network will be autonomous by 2021.¹² And despite regulatory barriers caused by legislation written before the advent of autonomous technology, GM announced plans to put a vehicle with no pedals or steering wheel into mass production by 2019.¹³

As we enter a new phase of commercialized autonomous technology, we must do so cautiously. While known for autonomous vehicle testing, Arizona has already been the home of one fatal crash during a road test administered by Uber. There is currently no standard for collecting data on AV pilot programs, making it difficult to judge the collective level of quality in the industry.¹⁴ On top of that, consumer acceptance of the technology is not guaranteed. Dr. Gill Pratt of Toyota's Research Institute posits that autonomous vehicle technology should be used, from an ethical perspective, as soon as it is measurably better than human drivers.¹⁵ However, even when AVs are statistically safer than human drivers, there will still be accidents. And as consumer opinion tends to have an outsized reaction to failure, premature commercialization could produce notable failures that set the entire industry back.

While caution is warranted, we are collectively entering a new phase for autonomous vehicles. The criteria for success is rapidly transitioning from technical ability to customer acceptance. Commercial success will power the exponential growth of vehicle miles traveled (VMT) for self-driving cars. The race is now to demonstrate and deliver on consumer value.

Exponential Change Breaks Predictions



THE FUTURE TARGET

How do we forecast a product or service here?

To create break-through concepts that exist in the innovation space, we can't rely on previous experience alone. We must challenge the natural tendency to use linear thinking to imagine the future.

ASSUMPTIONS

Based on current trends:

"Autonomous technology will super-charge OnDemand Mobility"

Based on past trends:

"Autonomous technology will allow OEMs to simply sell more cars"

Seeing Beyond the Perceived Horizon

► LIMITS TO CURRENT COMMERCIALIZATION MODELS

Many in the auto industry are confidently working on strategies that will succeed technologically and gather new riders. However these strategies are still likely to miss critical opportunities in autonomous technology. Most current commercialization concepts for AVs fall into one of two modalities: 1) Pay to Own or 2) Pay to Use. While both approaches are sure to contribute to increased autonomous use, neither are likely to account for the total miles traveled by autonomous cars in a rapidly shifting market.

The primary consumer draw for the Pay to Own model is the promise of increased safety from self-driving technology. Human error accounts for 94 percent of traffic accidents,¹⁶ and robots simply do not get distracted, get drunk or choose to engage in risky driving behavior. Consumer reaction to advanced driver assist safety features suggests that the promise of safety can attract buyers at a premium.

For the Pay to Use model, major TNCs such as Lyft, Uber and Didi are investing heavily in autonomous vehicle research. The human driver is the largest expense in the cost of a hailed ride. Today, with gas powered, human driven vehicles, the break-even point for ride hailing is around 3,500 miles in a year.¹⁷ Beyond that distance, it makes more financial sense to drive yourself in a privately-owned vehicle. In the future, the price per mile in an electric autonomous vehicle will plummet from roughly \$2.15/mile to 25¢/mile.¹⁸ This would make “all ride hailing all the time” cost competitive with the price of a standard three year new car lease. Even without disrupting private ownership, a substantial price decline will supercharge the on-demand mobility market.

In order to stay truly competitive, industry players must recognize that there is an innovation space opening up beyond the current models. When disruptive, transformative products are brought to market, they tend to defy easy prediction, which means some commercialization strategies that succeed will likely surprise us.

► A FRAGMENTED TRANSPORTATION MARKET

AV technology is poised to significantly alter how passengers consider their mobility options. Based on vehicle miles traveled, current transportation patterns are staggeringly monolithic. In the US, more than 114 million cars transport a single driver every day, and more than 76 percent of Americans drive to work alone.¹⁹ With the introduction of autonomous vehicles, it is likely to fragment this market rather than neatly replace one technology with a better successor. As a metaphor, AV adoption will not resemble the advent of the DVD, which neatly replaced the clearly inferior VHS cassettes. Rather, the automotive transition is more likely to resemble the cable-cutting phenomenon. While there's been decline in traditional cable TV viewership, it has not been replaced by single alternative, but to a wide variety of services across multiple devices. This fragmentation in transportation will be driven, in part, because there are significant frictions holding back both Pay to Own or Pay to Use as a superior solution.

For pay to own, the cost of the technology could complicate adoption for decades. Consumer research has revealed significant resistance when the technology adds more than \$500 to the overall cost to the vehicle.²⁰ Optimistic estimates from IHS show that self driving tech will add between \$7,000 to \$10,000 to the sticker price in 2025 and fall to \$5,000 by 2030.²¹ A 2016 McKinsey study estimated that once technological and regulatory issues have been resolved, up to 15 percent of new cars sold in 2030 could be fully autonomous.²² In the United States, there are roughly 275 million cars on the road. As Alex Roy points out, 17 million are replaced annually. If suddenly all cars sold were fully autonomous, it would take 16 years to get to 100 percent ubiquity.²³ A growth to 15 percent annually would be significant, but signals a deeply diversified, rather than unified market.

For Pay to Use, large scale changes in behavior will take time, and some trip types will prove resistant to ride hailing. Despite the public attention given to ride hailing, TNCs still represent a fairly small percentage of travel. In North America, they have captured less than 2 percent of VMT,²⁴ and this percentage isn't distributed evenly. In areas such as San Francisco, the percentage has climbed above 20 percent of VMT.²⁵ It would be a historic transformation if the rest of the country caught up. Given the scale of this change, even with rapid growth, it would take many years for the rest of the country to resemble the Bay Area. Some projections suggest TNCs could capture roughly 30 percent of VMT by 2030 with over half being delivered by AVs.²⁶ Successful TNCs like Uber have changed passenger assumptions by overcoming the first barrier and getting drivers out of their personal vehicles. That audience may now be primed for further experimentation. One study suggests that frequent TNC riders are twice as likely to use a self-driving vehicle.²⁷

Passenger trust in the safety of autonomous technology is another wildcard that could keep the market volatile. Studies of consumer sentiment towards AV technology are showing a wide range of results, which suggests that the market hasn't settled on an overall opinion yet. High profile failures such as Uber's fatal crash in Arizona can have an outsized impact on public opinion because consumer encounters with AV technology have been limited. A 2017 Gartner study found 55 percent of respondents would not even consider riding in a self-driving vehicle.²⁸ However, the trends seem to be improving. AAA released a study in 2018 that showed the percentage of respondents that "feared" riding in a self-driving car declined from 78 percent to 63 percent in one year.²⁹ A timid audience will warm to the technology as exposure increases, but upstarts may find success attracting passengers for the first time with alternative value propositions.

Rather than competing head to head with the ownership or ride hailing models, upstarts can compete asymmetrically by enticing users with new deployment models that address other needs. One of the many things Tesla has proven is that it is possible to create an automotive startup. The traditional barriers to entry for competing in transportation are being lowered by inexpensive manufacturing, increasingly affordable off-the-shelf electric drive trains and digital go-to-market strategies that sidestep the traditional dealer networks. For example, James Dyson, the industrial designer famous for his vacuum cleaners, has announced that he will spend \$2 billion to bring an electric vehicle to market.³⁰ Bob Lutz, former Chairman of GM, estimated that a startup could spend \$200-\$300 million to bring an electric vehicle to market.³¹ While this seems like a lofty cost at first, Uber has raised more than \$18 billion in investment.³² At a price as low as \$300 million, a huge variety of entrants could try new approaches in market. This clearly signals a new phase filled with experimentation as automotive players look for new ways to compete.

This likely fragmented transportation market will become an ecosystem that stimulates new commercial entrants with new value propositions. However, times of exponential change do not go on indefinitely. As explosive change slows, it will transition into a new stable competitive environment at the top of the S-Curve.³³ The foundation of that new market will likely emerge out of the innovation space that sits beyond growth projections of current trends. Survival may depend on being able to execute in a competitive environment that doesn't yet exist. Here is one example of a provocation method for systematic exploration of the innovation space.

Design for Unexpected Futures

► STRUCTURED IDEATION AS A SEARCH METHODOLOGY

It may seem that the future of mobility is being forged by those select few with the special gift of foresight. And although Elon Musk's reputation as a visionary may be well deserved, the truth is, creativity can be understood and replicated by anyone. We frequently adapt ideation methods from cognitive psychology, social sciences or management theory.³⁴ These methods provide any willing mind with a set of tools to conduct a creative search of the innovation space. One such model is the Provocation Method. The human mind, as it matures, must develop linear patterns to exist in the world in any reasonable way. These linear thinking patterns make projecting current patterns forward feel natural, even inevitable. And yet, with any sufficiently transformative technology, we are usually surprised by what succeeds. The future has no particular respect for our assumptions. In order to predict potential, we must question our assumptions in a productive way. Assumptions can be broken by employing the creative engine of the provocation method. By systematically feeding our assumptions into that mechanism, it shines a light on alternative futures.


These structured ideation methods can be used by a small group to quickly stimulate progress or applied systematically by a large multidisciplinary group over time to conduct a thorough search of the innovation space. In a day-long frogThink session with clients, we often produce several dozen concepts. During a recent project with a TNC, we generated several hundred concepts during the first four weeks. This may seem overwhelming, but ideation isn't the beginning of commercialization—it's the beginning of design, prototyping and evaluation. After generating the ideas, we apply a multi-factor analysis in order to make informed decisions about which ones to explore further. For our TNC client, we synthesized the ideas into thematic clusters, then applied evaluation criteria to plot the rankings of the concepts clusters. On one axis, we evaluated how meaningful the concept would be to users, combining how well it was differentiated, addressed a need, or might provoke users to recommend it to others. On the other axis we evaluated how well the concept worked for the business: is it achievable, defensible and does it match brand purpose and permission? Plotting the concepts based on six evaluation factors allowed for the best concepts to emerge without bias.

► **PROVOCATION METHOD**

The worksheet below presents the steps of the provocation method, which can be used to break standing assumptions and begin realizing opportunities otherwise missed. In Step 4 of this example, we're ready to start drawing ideas:


+ CONCEPTS
PROVOCATION

ESCAPE




Cancel, or remove what we take for granted
e.g. "cars don't have wheels"

REVERSAL



Reverse the normal flow or order of things
e.g. "passengers serve the flight attendants"

EXAGGERATION



Exaggerate the normal quality or make a wish
e.g. "this keyboard has only one button"

STEP 1: FOCUS

Increase vehicle Miles Traveled (VMT) in Autonomous Vehicles

STEP 2: ASSUMPTIONS YOU TAKE FOR GRANTED

- AVs are safer than human drivers
- Riders don't trust AVs
- Riders enjoy found time in AVs
- Buyers will pay more for AVs
- TNCs will not have human drivers
- Drivers will miss the act of driving

STEP 3: PROVOCATIONS

EXAGGERATION	Only AVs are allowed to drive
ESCAPE	AVs are thrillingly unsafe
EXAGGERATION	Riders will live in AVs
REVERSAL	Autonomous vehicles will pay for riders
ESCAPE	Humans will find new roles in TNCs
ESCAPE	Riders can dictate how AVs drive

STEP 4: CHOOSE THE BOLDEST

Autonomous vehicles will pay for riders — Mobility as Amenity?

► MOBILITY AS AMENITY

In the example seen in the Provocation Method on page 11, by applying the “reversal” provocation to our assumption that people must pay for their own transportation, we now have an open path to imagine a wide range of concepts in which the assumed relationship is turned on its head—a relationship where the transportation is provided as a perk, or what we call Mobility as Amenity.

When evaluating concepts, we often ask how a given concept enables a business to address an underlying force shaping their market. This is especially pertinent for the auto industry right now, as it is currently undergoing a historic transition. We are seeing the center of gravity in this landmark industry shift from “product” to “platform.” For over 100 years, cars have represented the pinnacle of product—the ultimate embodiment of the “American Dream.” While the industry is complex, the relationship that surrounds the automotive product is largely a straightforward one between buyer and seller. The OEMs seek to maximize the value offered to the consumer by maximizing performance, improving safety specifications and making the cars aesthetically desirable.

However, in a platform economy, it becomes a four-party relationship,³⁵ with Providers (such as Lyft) and Programmers (such as SiriusXM, Google Maps, usage-based insurers and more) introduced into the mix. The value to the customer isn’t just measured by the inherent value in the product, but rather in its ability to connect the passenger to the integrated services and content they care about. The center of value in a “platform” exists in the interactions. Although some amenity transport services already exist in the market, such as complimentary hotel or car rental shuttles, they represent only a tiny percentage of total miles traveled. Connected, autonomous vehicle technology will significantly increase the number and types of providers and programmers that could have a stake in the ride. Moving forward, this class of Mobility as Amenity concepts provides another way for automotive and transportation companies to capitalize on the value that will exist in orchestrating connections between these parties.

► COMPETING ON EXPERIENCE

Historically, transportation has been fairly expensive for consumers. For households, it’s generally the fourth largest single expense behind health, housing and food.³⁶ In this context, it’s difficult to imagine any significant transportation option for which the end user isn’t also the primary buyer of that service. But the convergence of autonomous vehicles, electric drive trains and connected services has multiple, mutually reinforcing factors driving down total cost per mile. These factors may actually push down the price far enough to shift from simply being less expensive for the end consumer, to a new paradigm where a third

party finds value in paying for the transportation their customers. In effect, our creative search can challenge the “Pay” in Pay to Use and Pay to Own models. Overall, this opens a third major commercialization modality. In this case, OEMs could be rewarded for VMT rather than on unit sales. This incentivizes a focus on user experience, building active, ongoing relationships with customers over time.

This future also has the potential to turn the car into an advertising platform. John Ellis’s book *Zero Dollar Car* (2017) argues that drivers will soon be able to trade their data for access to vehicles. There are multiple potential uses of the data described by Ellis, but the insight on the passengers used by advertisers is likely to be the most unique and valuable in the long term. The aptly named WaiveCar in Santa Monica, CA offers free rides in cars monetized through advertising applied to the exterior of the vehicle.³⁷ There are also a variety of advertising funded ride services in modified electric carts that transport passengers around entertainment and business districts.³⁸ For Mobility as Amenity, the car shifts from powering an ad network or becoming a surface upon which to display ads to the car itself becoming a loss leader.

The goal of an ad is to encourage an individual to take an action; in many cases, to choose to come to a business. But considering Mobility as Amenity could redirect some of the customer acquisition spending from indirect to direct: rather than encouraging the customer with ads, a business will be able to simply pay for their ride to the business. An ever growing percentage of business traveler miles could be delivered by mobility services offered by competing hotels. It’s also possible to imagine a Yelp filter that allows a user to select from restaurants willing to pick up the cost of the trip. Just as free breadsticks or access to wifi became amenities used to bring customers into restaurants, free transportation could literally drive customers to their business. In this type of relationship, applied advertising isn’t necessarily needed or even desirable. The restaurant, as a programmer in platform terms, could expect a role in establishing the user’s experience during the ride to maximize their investment. An OEM or a mobility provider that allows the destination to have an influence on the quality or experiences of the trip could have a competitive advantage. As Koetzle and Doty of Forrester Research said, “Imagine booking a Disney vacation that includes autonomous transport to the property: Your children’s Disney experience will begin the moment they step into the vehicle.”³⁹

In any emerging market, when multiple parties converge on the same idea, it can often be a positive indicator that the inclination was correct. It may also signal that a new competitive space is forming around that idea. Take the example of May Mobility, an autonomous vehicle startup from Ann Arbor. May is focused on large B2B buyers that want to deliver transportation services. Their pilot program in the fall of 2017 partnered with Bedrock, the owner of roughly 100 commercial buildings in downtown Detroit. Many of Bedrock’s buildings are served by remote parking garages. By offering May’s AV service as an amenity, Bedrock can increase the appeal of their commercial office buildings and make downtown Detroit a more attractive option for workers.⁴⁰ May Mobility refers to their B2B strategy as “single payer.” In an abstracted sense, May Mobility is leveraging their capabilities in AV control systems to become a

mobility provider. More importantly, their service becomes a platform upon which passengers, employers and real estate holding companies interact and exchange value. To grow this platform, May Mobility will consider the needs of all of the participants on its platform. Each one has a stake in shaping the user experience in ways unprecedented in a traditional automotive product.

Other opportunity areas for both new business and technology may also arise for populations of people not willing or able to drive but still wanting to stay active. For example, Voyage is conducting a pilot program for gated retirement communities that allows residents access to transportation without needing to get behind a wheel.⁴¹ If competing communities work the cost of a transportation service into the HOA fees, a new significant addressable market will have opened up.

The important question is not when autonomous vehicles will be deployed but where they will be deployed.⁴² This refers to both the technical aspect of carefully selected geo-fenced areas, as well as finding concentrations of people with addressable needs. The theoretical impacts of Mobility as Amenity to other sectors such as retail, entertainment, hospitality and workplaces reveal a path for autonomous technology to move out laterally from simply being a transportation question, to being a larger experiential question. The future of autonomous mobility will ultimately be dictated by its ability to generate user value and enable more engaged human experiences.

Roadmapping the Unexpected Future

▶ ENTERING THE RACE

When entering this new diversified market place, it will be more important than ever to break free of standing assumptions in order to anticipate and design for the unexpected futures sure to come. The Provocation Method provides one example for how this can be done. frog has an entire suite of research tools and design methods to help our clients see beyond the current state of the market and gain a highly competitive edge.

Get in touch to start a conversation today about how frog can help your business design and build for the automotive industry of tomorrow.

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Theo Calvin, Creative Director, co-leads the automotive practice in frog's Austin studio.

To start a conversation about designing for the unexpected future of autonomous mobility, contact business@frogdesign.com

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